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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/188,190	11/10/1998	KATSUNORI KANEKO	1472-177P	4015

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EXAMINER
NGUYEN, TU MINH

ART UNIT	PAPER NUMBER
3748	23

DATE MAILED: 07/02/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary

Application No.	Applicant(s)
09/188,190	Kaneko et al.
Examiner	**Art Unit**
Tu M. Nguyen	3748

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Jun 20, 2002* .

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above, claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *1-14* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☒ The proposed drawing correction filed on *Aug 25, 2000* is: a) ☒ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☒ All b) ☐ Some* c) ☐ None of:

1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____
4) ☐ Interview Summary (PTO-413) Paper No(s). _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

1. An Applicant's Request for Continued Examination (RCE) filed on June 20, 2002 has been entered. Per instruction from the RCE, an Applicant's Amendment filed on March 20, 2002 has been entered. Claims 5-7 have been amended. Overall, claims 1-14 are pending in this application.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless -
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371© of this title before the invention thereof by the applicant for patent.
>
> The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

3. Claims 1 and 8-14 are rejected under 35 U.S.C. 102(e) as being anticipated by Hepburn et al. (U.S. Patent 5,974,788).

Re claim 1, as shown in Figure 1, Hepburn et al. disclose an exhaust gas purifying apparatus of an internal combustion engine, comprising:

- exhaust gas purifying means (32), having a function of a three-way catalyst (the purifying means (32) of Hepburn removes HC, CO, and NO_x in the exhaust gas at stoichiometric or slightly rich condition (lines 13-18 and 39-48 of column 1)) provided in an exhaust passage of the internal combustion engine, for absorbing NO_x in an exhaust gas when an air-fuel ratio of the exhaust gas is lean, and means (20, 16) for releasing or reducing the absorbed NO_x when an oxygen concentration of the exhaust gas is reduced;

- a light-off catalyst (26) provided upstream of the exhaust gas purifying means in the exhaust passage, the light-off catalyst having a lower O_2 storage capability than the exhaust gas purifying means (lines 48-50 of column 4), the light-off catalyst and the exhaust gas purifying means are in an exhaust passage in series so that all the exhaust gas from the engine passes through both the light-off catalyst and the exhaust gas purifying means regardless of the engine operation modes; and

- control means (20) for controlling the air-fuel ratio of the exhaust gas so that an atmosphere having a reduced oxygen concentration is produced around the exhaust gas purifying means (32) when an NO_x conversion efficiency of the exhaust gas purifying means is decreased,

wherein a substance (SO_x) decreasing the NO_x conversion efficiency of the exhaust gas purifying means is released during the operation of the control means and is converted by the function of the three-way catalyst of the exhaust gas purifying means.

As indicated on lines 23-25 of column 1 and lines 64 of column 2 to line 5 of column 3, during a lean mode in the apparatus of Hepburn et al., in addition to NO_x, SO_x also accumulates in

the exhaust gas purifying means (32) in the form of a sulfate, occupying the storage sites that would be otherwise used to store the nitrates of NO_x. This clearly causes a reduction in NO_x conversion efficiency of the purifying means (32). Thus, to restore the NO_x conversion efficiency of the purifying means, the sulfates stored in the purifying means (32) are occasionally purged and reduced by modulating the amplitude of the air-fuel ratio at a properly chosen frequency to create a rich break-through of the light-off catalyst. In this way, an atmosphere having large unburned HC and CO concentration is produced around the exhaust gas purifying means for the effective purging and reduction of the sulfates.

The mechanism of purging and reduction of sulfates stored in the purifying means is similar to the three-way catalytic purging and reduction of nitrates. The only apparent difference is the higher temperature required for the sulfate purging. During the purging of sulfates, the exhaust gas entering the purifying means is enriched with unburned HC and CO. The oxidation of HC and CO with oxygen raises the temperature of the purifying means to at least 650°C, causing the release of the sulfates from the storage sites in the purifying means, which are then reduced by an endothermic reaction with the rest of HC and CO to form the more preferred SO_2 gaseous substance that can be released to the environment (also see lines 13-18 of column 1).

Re claim 8, in the exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is a spark ignition type four-cycle engine that operates on the four-stroke cycle consisting of a suction stroke, compression stroke, combustion/expansion stroke, and exhaust stroke.

Re claim 9, in the exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is an in-cylinder injection type engine in which fuel is directly injected into a combustion chamber (lines 3-6 of column 2).

Re claims 10 and 11, the single catalyst of the exhaust gas purifying means (32) in the exhaust gas purifying apparatus of Hepburn et al. functions as a three-way catalyst.

Re claim 12, the light-off catalyst (26) in the exhaust gas purifying apparatus of Hepburn et al. includes a single catalyst that functions as a three-way catalyst (lines 12-13 of column 2).

Re claim 13, the exhaust gas purifying means (32) in the exhaust gas purifying apparatus of Hepburn et al. functions also as an NO_x catalyst.

Re claim 14, the light-off catalyst (26) in the exhaust gas purifying apparatus of Hepburn et al. also functions as a SO_x catalyst to oxidize and convert SO_2 in the exhaust gas to a sulfate which can be absorbed by the exhaust gas purifying means.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. as applied to claim 1 above, in view of design choice.

The exhaust gas purifying apparatus of Hepburn et al. discloses the invention as cited above, however, fails to disclose that an amount of oxygen absorbed on the light-off catalyst is not greater than about 150 cc per one-liter volume of the catalyst when measured by an oxygen pulse method and that an oxygen component stored in the light-off catalyst is not greater than about 25 gr per one-liter volume of the catalyst.

One having ordinary skill in the art of exhaust emission control would have recognized that the specification of the maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst would be a function of many variables such as the size of the light-off catalyst, engine size, engine operating conditions (load, speed, etc), air and fuel properties, capacity and size of a main catalyst, etc. Moreover, there is nothing in the record which establishes that the claimed maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst presents a novel of unexpected result (See *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975)).

6. Claims 1 and 8-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Araki et al. (U.S. Patent 5,850,735).

Re claim 1, as shown in Figure 1, Hepburn et al. disclose an exhaust gas purifying apparatus of an internal combustion engine, comprising:

- exhaust gas purifying means (32), having a function of a three-way catalyst (the purifying means (32) of Hepburn removes HC, CO, and NO_x in the exhaust gas at stoichiometric or slightly rich condition (lines 13-18 and 39-48 of column 1)) provided in an exhaust passage of the internal combustion engine, for absorbing NO_x in an exhaust gas when an air-fuel ratio of the exhaust gas is lean, and means (20, 16) for releasing or reducing the absorbed NO_x when an oxygen concentration of the exhaust gas is reduced;

- a light-off catalyst (26) provided upstream of the exhaust gas purifying means in the exhaust passage, the light-off catalyst having a lower O_2 storage capability than the exhaust gas purifying means (lines 48-50 of column 4), the light-off catalyst and the exhaust gas purifying means are in an exhaust passage in series so that all the exhaust gas from the engine passes through both the light-off catalyst and the exhaust gas purifying means regardless of the engine operation modes; and

- control means (20) for controlling the air-fuel ratio of the exhaust gas so that an atmosphere having a reduced oxygen concentration is produced around the exhaust gas purifying means (32) when an NO_x conversion efficiency of the exhaust gas purifying means is decreased,

wherein a substance (SO_x) decreasing the NO_x conversion efficiency of the exhaust gas purifying means is released during the operation of the control means (as indicated on lines 23-25 of column 1 and lines 64 of column 2 to line 5 of column 3, during a lean mode in the apparatus of Hepburn et al., in addition to NO_x, SO_x also accumulates in the exhaust gas purifying means (32), occupying the storage sites that would be otherwise used to store NO_x. This clearly causes

a reduction in NO_x conversion efficiency of the purifying means (32). Thus, to restore the NO_x conversion efficiency of the purifying means, the SO_x stored in the purifying means (32) are occasionally purged and "burned" off by modulating the amplitude of the air-fuel ratio at a properly chosen frequency to create a rich break-through of the light-off catalyst. In this way, an atmosphere having large unburned HC and CO concentration is produced around the exhaust gas purifying means for the effective purging and combustion of SO_x).

Hepburn et al., however, fail to disclose in specific detail the mechanism in which SO_x is purified by the exhaust gas purifying means.

Araki et al. teach a method for purifying exhaust gas, that clearly describes in detail the mechanism of absorption and desorption of sulfur species in a SO_x absorbent (5) (lines 5-57 of column 7). They teach that the mechanism of purifying SO_x in the exhaust gas is similar to the three-way catalytic purification of NO_x in which the harmful emissions of NO_x, HC, and CO in the exhaust gas are eliminated. The only apparent difference is the higher temperature required for the SO_x purging. During a lean engine cycle, sulfur compounds in the exhaust gas are oxidized and absorbed by an absorbent layer of the SO_x absorbent in the form of a SO_4 sulfate. To purge the sulfate from the SO_x absorbent, the engine operation is switched to fuel rich to generate a reductant rich environment that contains excess unburned HC and CO. In this reductant rich environment, the temperature of the SO_x absorbent is substantially raised by the oxidization of the excess HC and CO. The high temperature induces the desorption of SO_4 from the absorbent layer, which is then reduced by the excess HC and CO to become either SO_2 (gaseous state) or

SO_3 (solid state). During the desorption of SO_4, Araki et al. selectively raise the exhaust gas to a temperature above a predetermined value and lower the oxygen content in the exhaust gas to minimize the conversion of SO_4 to SO_3 which is in a solid state (see Figures 2 and 3). In this way, more sulfur compounds (SO_2) in the gaseous state are transformed from SO_4; and an amount of particulate matters (in the form of SO_3) released into the atmosphere can be maintained at a low lever. It would have been obvious to one having ordinary skill in the art at the time of the invention was made, to have utilized the method taught by Araki et al. in the apparatus of Hepburn et al., since the use thereof would have minimized the generation of sulfur particulate matters which can clog up the exhaust gas purifying means.

Re claim 8, in the modified exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is a spark ignition type four-cycle engine that operates on the four-stroke cycle consisting of a suction stroke, compression stroke, combustion/expansion stroke, and exhaust stroke.

Re claim 9, in the modified exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is an in-cylinder injection type engine in which fuel is directly injected into a combustion chamber (lines 3-6 of column 2).

Re claims 10 and 11, the single catalyst of the exhaust gas purifying means (32) in the modified exhaust gas purifying apparatus of Hepburn et al. functions as a three-way catalyst.

Re claim 12, the light-off catalyst (26) in the modified exhaust gas purifying apparatus of Hepburn et al. includes a single catalyst that functions as a three-way catalyst (lines 12-13 of column 2).

Re claim 13, the exhaust gas purifying means (32) in the modified exhaust gas purifying apparatus of Hepburn et al. functions also as an NO_x catalyst.

Re claim 14, the light-off catalyst (26) in the modified exhaust gas purifying apparatus of Hepburn et al. also functions as a SO_x catalyst to oxidize and convert SO_2 in the exhaust gas to a sulfate which can be absorbed by the exhaust gas purifying means.

7. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Araki et al. as applied to claim 1 above, and further in view of design choice.

The modified exhaust gas purifying apparatus of Hepburn et al. discloses the invention as cited above, however, fails to disclose that an amount of oxygen absorbed on the light-off catalyst is not greater than about 150 cc per one-liter volume of the catalyst when measured by an oxygen pulse method and that an oxygen component stored in the light-off catalyst is not greater than about 25 gr per one-liter volume of the catalyst.

One having ordinary skill in the art of exhaust emission control would have recognized that the specification of the maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst would be a function of many variables such as the size of the light-off catalyst, engine size, engine operating conditions (load, speed, etc), air and fuel properties, capacity and size of a main catalyst, etc. Moreover, there is nothing in the record which establishes that the

claimed maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst presents a novel of unexpected result (See *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975)).

8. Claims 2 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Takeshima (U.S. Patent 5,448,887).

Re claim 2, as shown in Figure 1, Hepburn et al. disclose an exhaust gas purifying apparatus of an internal combustion engine, comprising:

- exhaust gas purifying means (32), provided in an exhaust passage of the internal combustion engine, for absorbing NO_x in an exhaust gas when an air-fuel ratio of the exhaust gas is lean, and means (20, 16) for releasing or reducing the absorbed NO_x when an oxygen concentration of the exhaust gas is reduced;

- a light-off catalyst (26) provided upstream of the exhaust gas purifying means in the exhaust passage, the light-off catalyst having a lower O_2 storage capability than the exhaust gas purifying means (lines 48-50 of column 4), the light-off catalyst and the exhaust gas purifying means are in an exhaust passage in series so that all the exhaust gas from the engine passes through both the light-off catalyst and the exhaust gas purifying means regardless of the engine operation modes; and

- control means (20) for controlling the air-fuel ratio of the exhaust gas so that an atmosphere having a reduced oxygen concentration is produced around the exhaust gas purifying means (32) when an NO_x conversion efficiency of the exhaust gas purifying means is decreased,

wherein a substance (SO_x) decreasing the NO_x conversion efficiency of the exhaust gas purifying means is released from the exhaust gas purifying means during the operation of the control means by CO break-through in the light-off catalyst.

As indicated on lines 23-25 of column 1 and lines 64 of column 2 to line 5 of column 3, during a lean mode in the apparatus of Hepburn et al., in addition to NO_x, SO_x also accumulates in the exhaust gas purifying means (32), occupying the storage sites that would be otherwise used to store NO_x. This clearly causes a reduction in NO_x conversion efficiency of the purifying means (32). Thus, to restore the NO_x conversion efficiency of the purifying means, the SO_x stored in the purifying means (32) are occasionally purged and "burned" off by modulating the amplitude of the air-fuel ratio at a properly chosen frequency to create a rich break-through of the light-off catalyst. In this way, an atmosphere having large unburned HC and CO concentration is produced around the exhaust gas purifying means for the effective purging and combustion of SO_x.

Hepburn et al., however, fail to disclose that the light-off catalyst has a constant HC conversion efficiency.

As shown in Figures 1 and 2, Takeshima teaches that the HC conversion efficiency for an upstream three-way catalyst (12) is relatively high and constant for an exhaust gas with a stoichiometric or fuel lean air-fuel ratio. The HC conversion efficiency, however, is relatively low and also constant for an exhaust gas with a fuel rich air-fuel ratio. It would have been obvious to one having ordinary skill in the art at the time of the invention was made, to have utilized the

teachings of Takeshima in the apparatus of Hepburn et al., since the use thereof would have provided a means to control the engine air-fuel ratio for the effective purifying of exhaust gas.

Re claim 5, in the modified apparatus of Hepburn et al., the light-off catalyst (26) has an oxygen storage capability of a first value; and the exhaust gas purifying means (32) having a function of a three-way catalyst has an oxygen storage of a second value which is greater than the first value (lines 48-50 of column 4).

9. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Takeshima as applied to claim 5 above, and further in view of design choice.

The modified exhaust gas purifying apparatus of Hepburn et al. discloses the invention as cited above, however, fails to disclose that an amount of oxygen absorbed on the exhaust gas purifying means having a function of a three-way light-off catalyst is not greater than about 150 cc per one-liter volume of the catalyst when measured by an oxygen pulse method and that an oxygen component stored in the exhaust gas purifying means having a function of a three-way light-off catalyst is not greater than about 25 gr per one-liter volume of the catalyst.

One having ordinary skill in the art of exhaust emission control would have recognized that the specification of the maximum volumetric or weighted amount of oxygen absorbed in the exhaust gas purifying means would be a function of many variables such as the size of the exhaust gas purifying means, engine size, engine operating conditions (load, speed, etc), air and fuel properties, capacity and size of a main catalyst, etc. Moreover, there is nothing in the record which establishes that the claimed maximum volumetric or weighted amount of oxygen absorbed

in the exhaust gas purifying means presents a novel of unexpected result (See *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975)).

Communication

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Tu Nguyen whose telephone number is (703) 308-2833.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mr. Thomas E. Denion, can be reached on (703) 308-2623. The fax phone number for this group is (703) 308-7763.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-1148.

Tu M. Nguyen

TMN

June 28, 2002

John J. Vrablik
Primary Examiner

Tu M. Nguyen
Patent Examiner
Art Unit 3748